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LETTER REPORT

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TECHNICAL TYPOGRAPHY USING PERSONAL COMPUTERS

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July 1989

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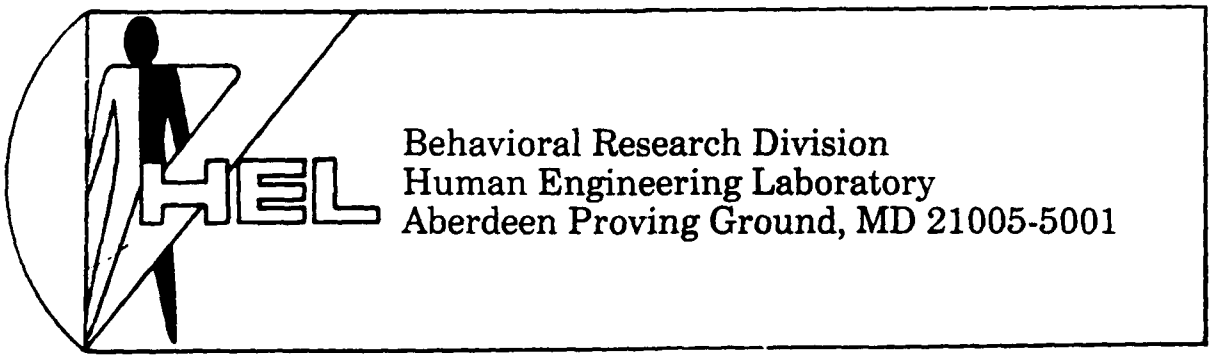

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ABSTRACT

Technical typography is fully within the capabilities of the personal computer. Two software packages seemed best able to meet our requirements: EXACT and PC TeX. This report describes the installation, use, capabilities, and results of these packages. Although both packages produce very good results, EXACT is, by far, the more suitable of the two for technical typesetting by general users. This program can answer most publication requirements. PC TeX is more appropriate for users involved in publishing technical manuscripts, who require the highest quality of technical typography. General users willing to expend the necessary time and effort to master PC TeX will find that outstanding results can be obtained. Both packages are acceptably fast when outputting to a laser printer, but only EXACT's draft mode is acceptable, in terms of speed, for generating output on a dot-matrix printer.

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TECHNICAL TYPOGRAPHY USING PERSONAL COMPUTERS

INTRODUCTION

The arrival of the Zenith 248 microcomputers at the Behavioral Research Division (BRD) substantially upgraded our computing capabilities. Our personnel quickly determined that these machines would make excellent data acquisition and experimental control devices, and many machines were modified to accomplish these tasks. Another use that was identified for these machines is the generation of high-quality technical typography. Since BRD also had acquired Hewlett-Packard LaserJet series II printers, we felt that this need could be met entirely by acquiring specialized software.

About the time we began to consider our software needs in this area, preparations were being made to type a doctoral dissertation in statistics (Grynovicki, 1989). The author made inquiries about having this document prepared on a word processor, but the complex symbology that was required could not easily be produced by standard word processing software. This was a clearly articulated need for technical typographic software.

Somewhat later in the process of selecting and acquiring the software, it became necessary to document a number of ballistic programs that had been written within BRD over the years. This documentation included many Greek and mathematical symbols. In addition, a new revision of MIL-STD-1474 (MI) (U.S. Army Missile Command) was being written. The revised document, MIL-STD-1474 (MI) (U.S.Army Missile Command, proposed), includes several complex formulae that could readily be prepared using software of this type.

When we began developing a technical typography capability, it was decided to satisfy this need, to the extent possible, solely by adding software to our existing microcomputer systems. Two software packages seemed best able to meet our needs. The first was EXACT by Technical Support Software, Inc. EXACT was selected based on the satisfactory performance of the demonstration version of the package. The second was PC TeX made by Personal TeX, Inc., and is one of several implementations of TeX for personal computers. PC TeX was chosen, based on an evaluation of desktop publishing software (Holmes, 1987), and on a favorable review in a report on technical word processors (Tetewsky, 1985).

OBJECTIVES

The objectives of this report are to describe the installation, the use, and the capabilities of EXACT and PC TeX, along with the results produced by them.

METHOD

Software

The software packages EXACT and PC TeX were installed as specified in their respective manuals. The operating system used was MS-DOS Version 3.2 (1986). Outputs were generated as described in the next section.

Hardware

In BRD, the Zenith 248s are equipped with 3,200 kilobytes of RAM, 80287 coprocessors, 20-megabyte hard drives, 360-kilobyte and 1.2-megabyte 5.25-inch floppy disk drives, enhanced graphics adapter (EGA) cards and EGA monitors, and ALPS dot-matrix printers (set to emulate Epson printers; see ALPS P2000G/P2100G Printer User's Guide, 1986). In addition, several of the machines are equipped with dual 20-megabyte IOMEGA cartridge drive systems and/or Hewlett-Packard LaserJet series II printers.

Procedures

Printing times were collected manually using a digital stopwatch. All times were from the last key stroke of the command to the end of the specified output. Each process was timed once. For EXACT and for source file listings, times were based on output through Microsoft Word Version 4.0. Character counts for files are those provided by Microsoft Word. TeX output was generated simply by using the appropriate printer drivers.

RESULTS AND DISCUSSION

EXACT

EXACT (1988) requires an IBM PC compatible computer with 64 to 128 kilobytes more RAM than what is normally needed to run your word processor, DOS 2.0 or higher, a word processor and a printer. Installation of EXACT requires that you first run the DEMO program on the EXACT demonstration disk, and then execute the INSTALL procedure. To install the LaserJet drivers, copy the files provided on the LaserJet drivers diskette to suitable directories, and then select the appropriate fonts and options using the UTILS.EXE program discussed later in this section. The next steps are to configure your word processor to use an appropriate printer driver and prepare any desired batch (.BAT) files.

Installation, configuration, and testing of EXACT can be accomplished in 15 minutes. The program and its associated files usually reside in one subdirectory for each printer type or LaserJet font cartridge used. Each set of files requires 371 kilobytes of storage space. For the LaserJet printer, EXACT supports the Hewlett-Packard "J" Math Elite or the "K" Math TMS (used in preparing Figure 1) cartridges (LaserJet Printer Family Font Catalog, 1986) and includes a driver for use without a cartridge. Thus, a typical installation for both of the supported LaserJet cartridges and

for a dot-matrix printer would occupy 1.1 megabytes of disk space and use three directories over and above any requirements for your word processor. An example of a directory structure for EXACT is in Appendix A. EXACT, with the dot-matrix printer driver, the LaserJet driver, and the EXACT to PC TeX translator program, costs about $700.00.

EXACT is best invoked by using a batch file such as the following:

```
CD\TMS
MARK
EXACT
CD\WORD
WORD
CD\EXACT
RELEASE
CD\
CLS
```

MARK and RELEASE are utility programs provided with the EXACT package. They respectively mark the memory location at which EXACT will begin to be loaded and release the memory that EXACT had occupied when the program finishes. EXACT loads the program itself, and Word loads the Microsoft Word program. EXACT is a program that remains resident in memory. It monitors the LPT1 printer port, intercepting command strings embedded in the document, and sending appropriate graphics commands to the printer. EXACT works closely with most common word processing programs; many of its features are accessed from within the word processor through function keys. We have used EXACT with Microsoft Word Version 4.0 (Using Microsoft Word, 1987) and with MicroPro Wordstar Professional Release 4.0 (1987), and have found these to be very satisfactory combinations when used with appropriate printer drivers (cf., Printer Information for Microsoft Word, 1987).

EXACT source files are created and saved as standard word processor files. For example, they are created and saved as formatted files in Microsoft Word (with a .DOC extension) and as document files in MicroPro Wordstar (with the extension of your choice).

EXACT has several interesting capabilities. It produces a full set of Roman, Greek, and mathematical characters in regular and miniature sizes. In all, 10 font styles covering 2 primary sizes are available for use. On the LaserJet, the "J" Math Elite cartridge provides monospaced characters in 7- and 10-point sizes while the "K" Math TMS cartridge provides 8- and 10-point proportional characters. In addition, EXACT can modify the size of any character by vertical stretching or by expanding it in both horizontal and vertical dimensions from two to nine times. Large magnification values produce characters or symbols that are objectionably grainy, however. For dot-matrix printer users, EXACT can typeset single lines containing equations or symbols, while outputting the rest of the document in a high-speed native font.

For ease in preparing complex formulae or matrices, EXACT offers an "edit session." In an edit session, you move into a special split screen mode in which you enter EXACT commands on a command line while the product of those commands takes shape in the upper part of the screen. When you are satisfied with the product, you can then readily inject the command string that produced the product in your document at any desired point. EXACT also supports extracting command strings from your document to an edit session for modification. In order to use the extraction feature, your word

processor must be in the character display mode as opposed to the graphics display mode. This feature is particularly useful in resolving tricky problems with the effects of a command string. Efforts to reinject the command string after extraction and re-editing can be difficult, because the string is always reinserted at the end of the document. This is the only problem we have experienced with the edit session feature, and it can be solved by manually moving the reinjected command string to the desired location.

EXACT also has a moderately powerful page preview feature. When using this preview, you are effectively printing your document to the screen in graphics mode. You can enlarge the page image to examine parts of individual formulae in detail or shrink the image to gain an appreciation of the appearance of the entire page. The process of drawing the first page to the screen requires 4 seconds on our equipment.

Document formatting tasks are shared between EXACT and your word processor. For normal text, line width, line and paragraph spacing, page layout, and pagination are handled entirely by your word processor. While EXACT's formatting defaults will generally yield a satisfactory result for margins, precise formatting of margins will require some trial and error adjustment of both EXACT and word processor margin settings. Reconfiguration of default fonts, margins, and escape tables for EXACT is facilitated by the UTILS.EXE program, which is run from the DOS command line.

EXACT produces output of high quality on Hewlett-Packard LaserJet printers and on a wide variety of dot-matrix printers, including Epson and Epson-compatible printers. For dot-matrix printer users, EXACT supports both a high-speed draft quality output mode and a somewhat slower publication quality mode. A sample page from Chapter 3 of Grynovicki (1989) is shown in Figure 1 (reproduced on a LaserJet), Figure 2 (reproduced on an ALPS in EXACT's draft mode), and Figure 3 (reproduced on an ALPS in EXACT's publication mode). The corresponding page of the source document with its embedded command strings is shown in Figure 4. Note the $/HE/ and $/FO/ commands at the upper- and lower-left corners of the page. These commands respectively activate and deactivate EXACT, allowing the program to interpret the intervening command strings. The $/HE/ and $/FO/ may be included in Word headers and footers, or they can be typed manually as required.

The output of the 27-page EXACT test document containing 35,037 characters, which is chapter 3 (without the figures and tables) of Grynovicki (1989) required 222 seconds on the LaserJet; 913 seconds (15 minutes and 13 seconds) in the draft mode on the ALPS; and 3,207 seconds (53 minutes and 27 seconds) in the publication mode on the ALPS. The source document printed in 213 seconds on the LaserJet; 371 seconds in the draft mode on the ALPS; and 1,070 seconds (17 minutes and 50 seconds) in near letter quality mode on the ALPS. These timing figures, expressed in terms of characters of output per second, are shown in Figure 5. In this figure, Draft refers to the EXACT draft mode, Publish refers to the EXACT publication quality mode, and Source Dr. and Source NLQ refer to the draft and the near letter quality source file outputs, respectively. It is clear that EXACT slows the LaserJet only slightly, but the performance of the ALPS printer is substantially degraded.

A particular advantage of EXACT is the ease with which it combines with Microsoft Word or other word processing programs. Any skilled user of a suitable word processing program is already well on the way to becoming a competent EXACT user. EXACT's real-time edit mode, its preview, and its printing mode selection,

$$\frac{a\left[(1+\rho)\,\chi^2_{(a_2-2)} - (1-\rho)\,\chi^2_{(a_2-2)}\right]}{2}$$, where a is the variance of X_{12} and X_{22}, rho (ρ) is the correlation between X_{12} and X_{22}, and $\chi\ (a_2-2)$ is the central chi-square with (a_2-2) degrees of freedom.

Consider the product of deviations from the sample mean where X_1 and X_2 are singletons: $(X_1)\ (X_2)$

Let $X = (X_1, X_2)$

then $X = (X_1, X_2) \approx N_2\ (O, V)$

$$V = \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}$$

$$A = \begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}$$

Now

$$X_1X_2 = (X_1, X_2) \begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix} (X_1, X_2)$$

Figure 1. EXACT LaserJet output.

$\frac{a\left[1+\rho\ \chi^2(a_2-2)^{-(1-\rho)\chi^2}(a_2-2)\right]}{2}$, where a is the variance of X_{12} and X_{22}, rho (ρ) is the correlation between X_{12} and X_{22}, and χ^2 (a_2-2) is the central chi-square with (a_2-2) degrees of freedom.

Consider the product of deviations from the sample mean where X_1 and X_2 are singletons: (X_1) (X_2).

Let $X = (X_1, X_2)$

then $X = (X_1, X_2) \approx N_2 (0,V)$

$$V = \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}$$

$$A = \begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}$$

Now

$$X_1X_2=(X_1,X_2)\begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}(X_1,X_2)$$

Figure 2. EXACT ALPS output (draft).

$\frac{a\left[1+\rho\ \chi^2(a_2-2)^{-(1-\rho)\chi^2(a_2-2)}\right]}{2}$, where a is the variance of X_{12} and X_{22}, rho (ρ) is the correlation between X_{12} and X_{22}, and $\chi^2\ (a_2-2)$ is the central chi-square with (a_2-2) degrees of freedom.

Consider the product of deviations from the sample mean where X_1 and X_2 are singletons: $(X_1)\ (X_2)$.

Let $X = (X_1, X_2)$

then $X = (X_1, X_2) \approx N_2\ (0,V)$

$$V = \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}$$

$$A = \begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}$$

Now

$$X_1X_2=(X_1,X_2)\begin{pmatrix} 0 & 1/2 \\ 1/2 & 0 \end{pmatrix}(X_1,X_2)$$

Figure 3. EXACT ALPS output (publication).

$/he/

$/fr/a$/[/$/(/1+$r$/)/ $@1c2$*%$/(/a$%2-2$/)/$**$**$=

-(1-$r)$@1c2$*%$/(/a$%2-2$/)/$**$**$/]/$,2$. , where a is the variance of X$*%12$**

and X$*%22$**, rho ($r) is the correlation between X$*%12$** $=

and X$*%22$**, and $@1$= c $/(/a$%2-2$/)/

is the central chi-square with $/(/a$%2-2$/)/ degrees of freedom.

Consider the product of deviations from the sample mean where X$%1 and X$%2 are singletons: $/(/X$%1$/)/ $/(/X$%2$/)/.

Let X = (X$%1, X$%2)

then X = (X$%1, X$%2) $@7Q N$%2 (O, V)

V = $/(/$: 3@1s$%1$#2 $@1s$%1$@1s$%2$r

$@1s$%1$@1sS%2Sr $@1s$%2$#2$.$/)/

A = $/(/$: 0 1/2

1/2 0$.$/)/

Now

X$%1X$%2=$/(/X$%1,X$%2$/)/$/(/$: 0 1/2

1/2 0$.$/)/ $/(/$: X$%1,X$%2$.$/)/

$/fo/

Figure 4. EXACT source document.

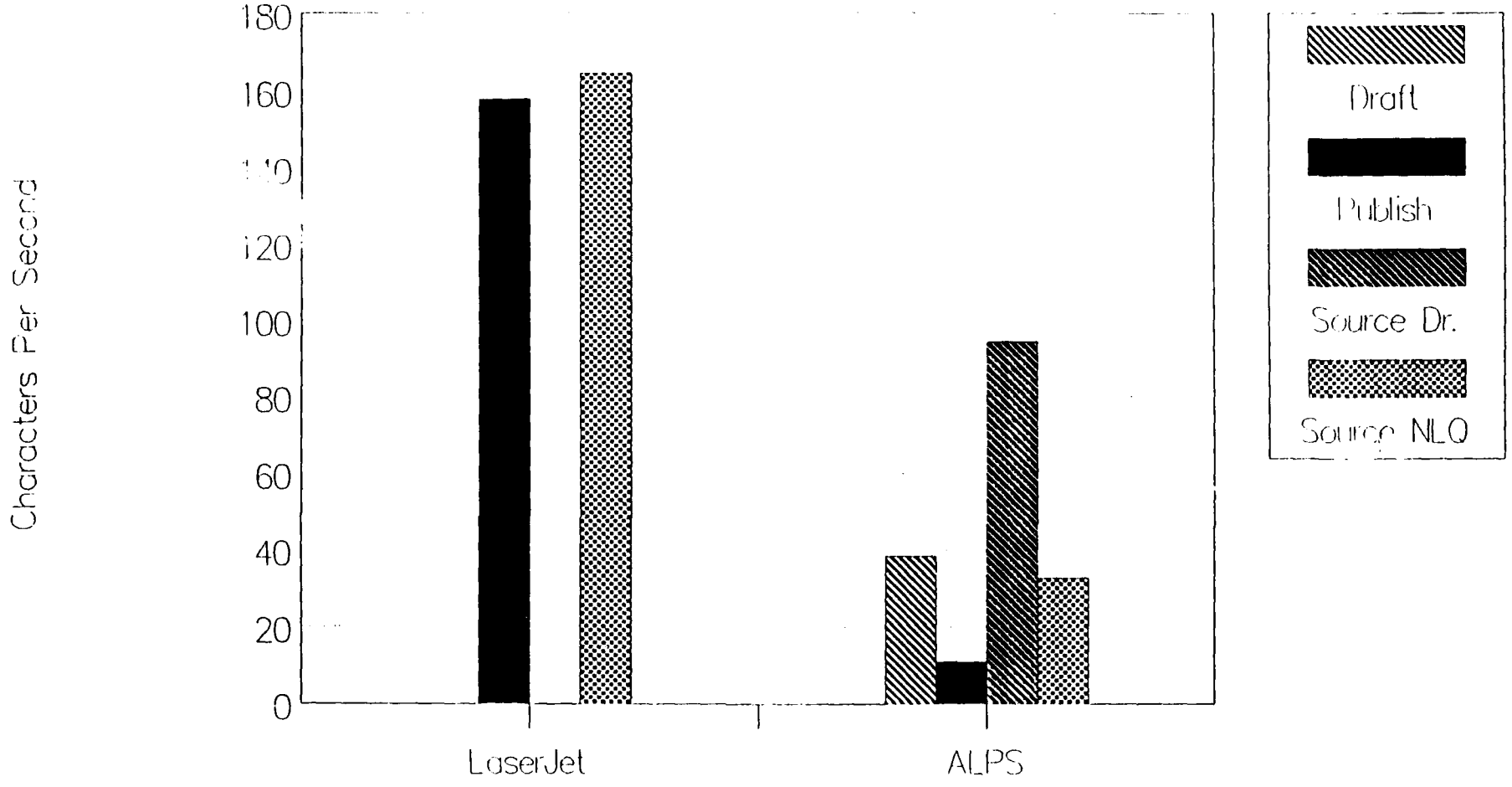

Figure 5. Performance of EXACT on LaserJet and ALPS printers.

to name only a few of its features, are all easily accessible from within your word processor. EXACT's user-friendly interface and informative command reference cards permit users to produce high-quality output after a brief tutorial.

Extensive experience with EXACT has revealed a line spacing problem that is very inconvenient to deal with in actual use, but it is also easily avoided, because it arises only when entire pages are placed between $/HE/ and $/FO/ commands. When spacing lines in this mode, EXACT allows the amount of space specified by your word processor to intrude between the lowest character on one line and the highest character on the following line. EXACT also attempts to spread the available lines evenly between the $/HE/ and $/FO/. This causes excessive spacing to be introduced when superscripts, subscripts, some special characters, and formulae are integrated into the text, and can result in a product that is unusable for some purposes. For LaserJet users, this problem can be circumvented by using your word processor to generate all superscripts, subscripts, and special characters (use the MATH-7, MATH-8, or PI fonts on the "J" Math Elite cartridge, or the MATH TMS, MATH-7, or PI fonts on the "K" Math TMS cartridge) used in the text portions of your material. Formulae or matrices would be displayed apart from the text, surrounded by $/HE/ and $/FO/ if they extend to multiple lines, or on a line with "}" in column 1 if they fit on a single-word processor line. This approach should also be effective on dot-matrix printers that support the required special characters.

EXACT's documentation (1988) is the easier of the two sets to use, particularly when a user needs to locate a particular bit of information. It includes a good manual with clear examples and, as noted earlier, an excellent assortment of command reference cards.

The technical support line, operating at a toll number, functions on a call-back basis. The technical support personnel were uniformly responsive and knowledgeable.

For users desiring or requiring still higher quality output, an EXACT to TeX Translator (1987) makes the textbook quality printing of the PC TeX package available. Our experience suggests that the results of this conversion will require some modification in order to yield a satisfactory product.

PC TeX

PC TeX (Spivak, 1985) requires an IBM PC-compatible computer with 512 kilobytes of RAM, a hard drive, DOS 2.0 or higher, a 5.25-inch floppy disk drive, a suitable word processor or editor, and a printer. PC TeX was originally written for larger computers and was recently adapted to personal computers. In addition, TeX Preview requires an EGA card and monitor, a Hercules graphics card and monitor, or one of several other specified card/monitor combinations. The installation of PC TeX (Spivak, 1987) requires that the user

(a) install the PC TeX program, the Hewlett-Packard drivers, and the Computer Modern (CM) fonts;

(b) initialize several TeX format files, install TeX Preview and two sets of Preview screen fonts;

(c) modify the Preview configuration file;

(d) prepare and install an editor;

(e) modify the PCTEX.CFG configuration file for the PCTEX menu;

(f) prepare any needed .BAT files; and

(g) copy a few other files into suitable directories.

A full-up installation of PC TeX with TeX Preview and their complements of Computer Modern printer and screen fonts requires 15 megabytes of storage space and 52 directories, although a satisfactory installation can be accomplished in a little less than half this space if fewer fonts are loaded. An example of such a directory structure is in Appendix B. The installation, configuration, and testing of PC TeX requires about 60 minutes. As a direct result of the size of this package, we have installed our copies on 20-megabyte Iomega cartridges. PC TeX, with the PTIHP/PTISPOOL driver/spooler combination for the LaserJet (Spivak, 1988a) and PCDOT printer driver for dot-matrix printers (Spivak, 1988b), TeX Preview (1988), MetaFont, and additional documentation (Knuth, 1986a; 1986b; Lamport, 1986; Spivak, 1986) costs about $1,000.00.

To use PC TeX to typeset your document, you must first generate an ASCII text file with its complement of PC TeX-embedded command strings using the nondocument mode of a word processor. Formatting the document by the word processor is unimportant; a blank line indicates a paragraph break, and all other output formatting tasks are handled either by the defaults specified in the style sheet you load into your text file or through command strings embedded in the text file. The text file must then be saved with a .TEX extension. You must then pass your pure ASCII .TEX file through, in order, the TeX program (TEX) which in turn produces a .DVI file, to a program to modify the TeX output file for your printer (PTIHP) that reads the .DVI file and outputs a .HP file, and a print spooler (PTISPOOL) that prints the .HP file. All of this is readily accomplished using a batch file of the type that follows:

```
TEX %1.TEX
PTIHP %1
PTISPOOL %1
```

This batch file outputs to a Hewlett-Packard LaserJet printer. To output to an Epson-compatible printer, such as the ALPS P2000G configured to emulate an Epson printer (ALPS P2000G/P2100G Printer User's Guide, 1986), replace the lines PTIHP %1 and PTISPOOL %1 with DVIEPS %1. The DVIEPS.BAT file calls the PC TeX PCDOT driver with appropriate command parameters for this printer type. PTISPOOL can access any of the standard COM and LPT ports, but PCDOT and PCLASER are restricted to the LPT1 port. PC TeX can also be configured to function as a menu-driven system with choices presented for an editor, TeX, Preview, PCDOT, and a laser printer driver. This menu is described in Appendix C.

The technical typesetting capabilities of the PC TeX program are virtually without limit. The output produced is kerned and microspaced, and, on the LaserJet, rivals the appearance of printed textbooks. Eighty-eight Computer Modern fonts are provided in the CM font set, in three to seven sizes up to 40-point. A full set of mathematical symbols is available in sizes to satisfy almost any requirement.

The PC TeX page preview capability is in a separate program called Preview (TeX Preview User's Manual, 1988). It is invoked from the DOS command line by typing PREVIEW TEST, where TEST is the output .DVI file produced by the TeX program.

This preview also supports zooming, but in addition, it has on-screen rulers to allow you to exactly judge the quality of the output that will be produced. PC TeX Preview requires 9 seconds to draw the first page of a document to the screen. Several seconds of this interval are taken up displaying the Preview logo.

PC TeX supports a wide variety of printers. Hewlett-Packard LaserJets are supported by the PTIHP driver, Cordata and related laser printers are supported by the PCLASER driver, and the PCDOT driver supports a wide variety of dot-matrix printers, including Epson and Epson-compatible printers. Drivers for Postscript printers are also available. When using PTIHP, PC TeX can incorporate graphics files saved in the Hewlett-Packard PCL format directly into your finished document.

As noted earlier, PC TeX requires a plain ASCII file, containing nothing but the characters to be printed and the relevant command strings as input. The files should have an extension of .TEX. Almost all text editors can produce files of this type, but our experience is that Wordstar Professional Release 4.0 (1987) is one of the better full-featured editors for this use.

PC TeX produces output of exceptional quality on a laser printer and copy of very usable quality on a dot-matrix printer. Printing a 27-page document containing 46,976 characters (Jamison, 1988) using the batch file given earlier requires 585 seconds on the Hewlett-Packard LaserJet series II, including 150 seconds of processing by TeX and 120 seconds of processing by DVIHP. On the ALPS P2000G, the process took 3,277 seconds (54 minutes and 37 seconds), including 150 seconds of processing by TEX. The source document, which was 17 pages long, printed on the LaserJet in 175 seconds, on the ALPS in draft mode in 370 seconds, and on the ALPS in near letter quality mode in 1,574 seconds (26 minutes and 14 seconds). These timing figures, expressed in terms of characters of output per second are shown in *Figure 6. In this figure*, PC TeX refers to the TeX typeset mode, while Source Dr. and Source NLQ refer to draft and near letter quality source file outputs, respectively. It is clear the PC TeX moderately degrades the performance of the LaserJet. However, when compared to the results obtained with EXACT, the ALPS printer is not as degraded by PC TeX. A sample page of the LaserJet output is shown in Figure 7; the same page of the ALPS output is shown in Figure 8; the corresponding page of the source document with its embedded command strings is shown in Figure 9.

Although it has many valuable features, PC TeX is more difficult to learn and use than is EXACT. There are two principal reasons for this: First, in PC TeX, all formatting is handled by TeX commands. (Nothing you know about your word processor will help you here.) Second, all the parts of the PC TeX system (e.g., PCTEX, PREVIEW, PTIHP, PTISPOOL, and your editor) are separate programs. (You are unlikely to ever forget that fact.)

PC TeX's documentation (Knuth, 1986a; 1986b; Lamport, 1986; Spivak, 1985; 1986; 1987; 1988a; 1988b; TeX Preview, 1987) is the more readable of the two sets, and large portions of it are actually entertaining to read, but it can be difficult to track down a specific item of information in the almost 1,800 pages that comprise these manuals. No command reference cards are included in this documentation set.

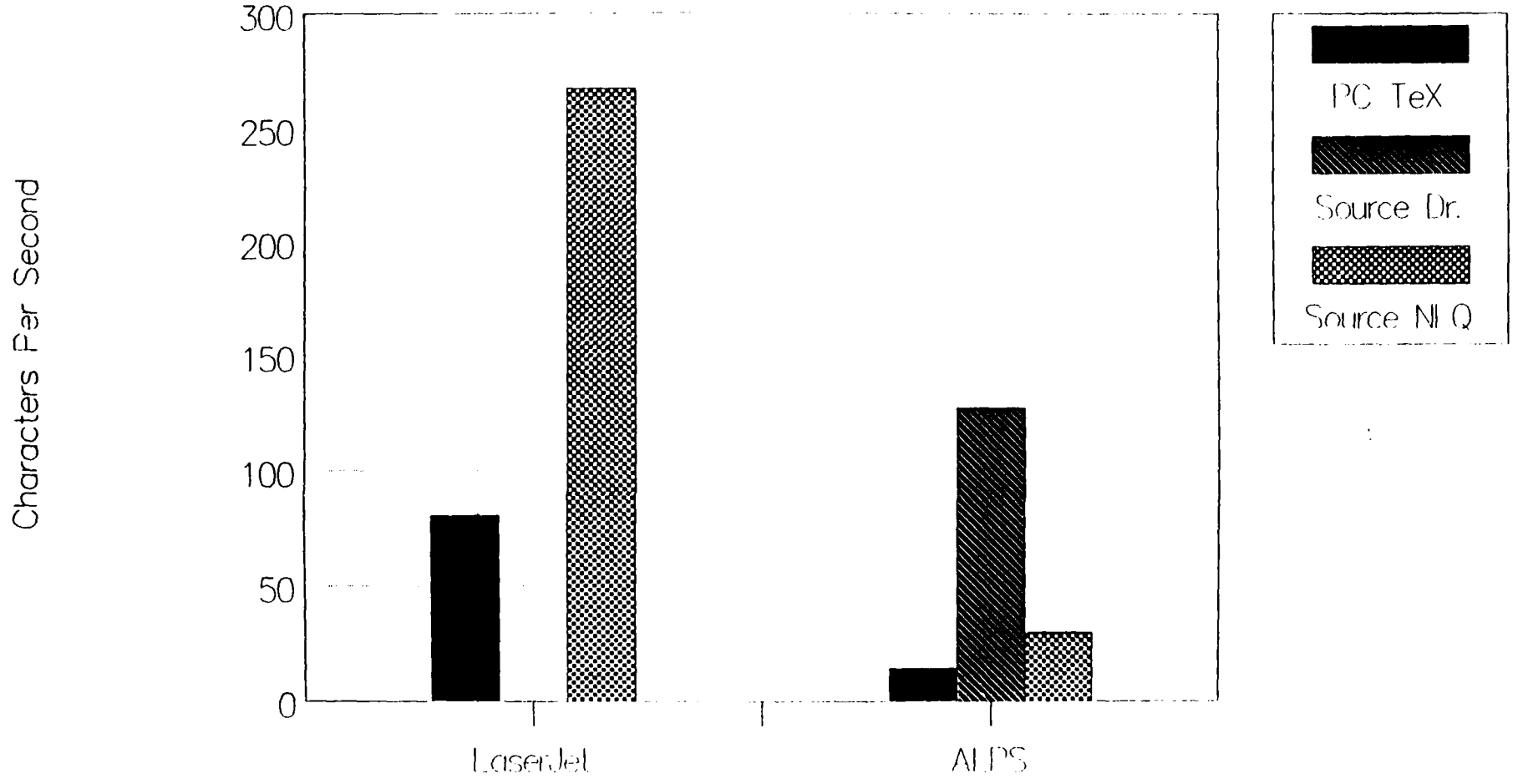

Figure 6. Performance of PC TeX on LaserJet and ALPS printers.

Formula Derivation for Miss Distance at a Known Range

DR. JOEL T. KALB

Given: R_t = Range to target
R_h = Range to hit
Assume: Hit occurs on line from obsever to target which is closer to target
Find: $\Delta\Theta$
$\Theta_1 = Tan^{-1}(R_t/H)$
$\Theta_2 = Tan^{-1}(R_h/H)$
$\Delta\Theta = \Theta_1 - \Theta_2 = Tan^{-1}(R_t/H) - Tan(R_h/H)$
$\Delta\Theta = Tan^{-1}\frac{R_t/H - R_h/H}{1+R_t/HR_h/H} =$
$Tan^{-1}\frac{(R_t-R_h)H}{R_tR_h+H^2}$
$D = R_t - R_h$
Given $\Delta\Theta$ Find $(R_h - R_t)$
$Tan(\Delta\Theta) = (R_t - R_h)HR_tR_h + H^2 = R_tH - R_hH$
$= R_tR_hTan\Delta\Theta + H^2Tan\Delta\Theta$
$R_h(H + R_tTan\Delta\Theta) = H(R_t - HTan\Delta\Theta)$
$R_h = \frac{H(R_t-H/Tan\Delta\Theta)}{H+R_tTan\Delta\Theta}$
$D = R_t - R_h = R_t - \frac{H(R_t-HTan\Delta\Theta)}{H+R_tTan\Delta\Theta} =$
$\frac{R_tH+R_t^2Tan\Delta\Theta-HR_t+H^2Tan\Delta\Theta}{H+R_tTan\Delta\Theta}$
$D = \frac{(R_t^2+H^2)Tan\Delta\Theta}{H+R_tTan\Delta\Theta}$
D is positive if hit is short of target
Angle $\Delta\Theta$ is positive if hit is short of target

1

Figure 7. PC TeX LaserJet output.

Formula Derivation for Miss Distance at a Known Range

DR. JOEL T. KALB

Given: R_t = Range to target
R_h = Range to hit
Assume: Hit occurs on line from obsever to target which is closer to target
Find: $\Delta\Theta$

$\Theta_1 = Tan^{-1}(R_t/H)$

$\Theta_2 = Tan^{-1}(R_h/H)$

$\Delta\Theta = \Theta_1 - \Theta_2 = Tan^{-1}(R_t/H) - Tan(R_h/H)$

$\Delta\Theta = Tan^{-1}\frac{R_t/H - R_h/H}{1+R_t/H R_h/H} =$

$Tan^{-1}\frac{(R_t - R_h)H}{R_t R_h + H^2}$

$D = R_t - R_h$

Given $\Delta\Theta$ Find $(R_h - R_t)$

$Tan(\Delta\Theta) = (R_t - R_h)H R_t R_h + H^2 = R_t H - R_h H$

$= R_t R_h Tan\Delta\Theta + H^2 Tan\Delta\Theta$

$R_h(H + R_t Tan\Delta\Theta) = H(R_t - HTan\Delta\Theta)$

$R_h = \frac{H(R_t - HTan\Delta\Theta)}{H + R_t Tan\Delta\Theta}$

$D = R_t - R_h = R_t - \frac{H(R_t - HTan\Delta\Theta)}{H + R_t Tan\Delta\Theta} =$

$\frac{R_t H + R_t^2 Tan\Delta\Theta - HR_t + H^2 Tan\Delta\Theta}{H + R_t Tan\Delta\Theta}$

$D = \frac{(R_t^2 + H^2)Tan\Delta\Theta}{H + R_t Tan\Delta\Theta}$

D is positive if hit is short of target
Angle $\Delta\Theta$ is positive if hit is short of target

1

Figure 8. PC TeX ALPS output.

```
\input vanilla.sty
\magnification=\magstep1
\title Formula Derivation for Miss Distance at a Known
Range\\
\endtitle
\author Dr. Joel T. Kalb\endauthor

\midspace {2.5in}

Given:
     $R_t =$ Range to target

     $R_h =$ Range to hit

Assume:  Hit occurs on line from obsever to target which is
closer to target

Find: $\Delta \Theta$

$\Theta_1 =Tan^{-1} (R_t/H)$

$\Theta_2 =Tan^{-1} (R_h/H)$

$\Delta\Theta=\Theta_1-\Theta_2=Tan^{-1}(R_t/H)-Tan(R_h/H)$

$\Delta\Theta=Tan^{-1}\frac{R_t/H-R_h/H}{1+R_t/H R_h/H}=$

 $Tan^{-1}\frac{(R_t-R_h)H}{R_tR_h+H^2}$

 $D=R_t-R_h$

Given $\Delta\Theta$       Find $(R_h-R_t)$

$Tan(\Delta\Theta)=\frac{(R_t-R_h)H}{R_tR_h+H^2}=R_tH-R_hH$

$=R_tR_hTan\Delta\Theta+H^2Tan\Delta\Theta$

$R_h(H+R_tTan\Delta\Theta)=H(R_t-HTan\Delta\Theta)$

$R_h=\frac{H(R_t-H/Tan\Delta\Theta)}{H+R_tTan\Delta\Theta}$

$D=R_t-R_h=R_t-\frac{H(R_t-
HTan\Delta\Theta)}{H+R_tTan\Delta\Theta}=$

  $\frac{R_tH+R_t^2Tan\Delta\Theta-
HR_t+H^2Tan\Delta\Theta}{H+R_tTan\Delta\Theta}$

$D=\frac{(R_t^2+H^2)Tan\Delta\Theta}{H+R_tTan\Delta\Theta}$

 D is positive if hit is short of target

 Angle $\Delta\Theta$ is positive if hit is short of target

\end
```

Figure 9. PC TeX source document.

For the cost of a toll call, telephone technical support is available. Additional customer support is provided by the newsletter Personal TeX News (e.g., 1988). Additional support is available through the TeX Users Group (P.O. Box 9506, Providence, RI 02940-9506, 401-272-9500).

CONCLUSIONS AND RECOMMENDATIONS

Both packages are of high quality and produce output that is more than satisfactory for our needs within BRD. A comparison of the features of the two programs is in Table 1. EXACT is superior in all categories, except for the number of fonts and font sizes available.

EXACT has been used to typeset a statistical dissertation (Grynovicki, 1989) and the formulae in the revised MIL-STD-1474 (MI). The results of this process indicate that this package is readily manageable both by our administrative and by our technical staff. This is largely a result of (a) the ease with which EXACT links to Microsoft Word, and (b) access to real-time editing and other program features from within the word processor. EXACT is clearly the easier of the two packages to install and to use, and it is much more compact, but it is also slightly limited both in its capabilities and in the quality of its output when compared to PC TeX.

PC TeX is a full-blown typesetting package with all the complexities that go with such an application. Installation of PC TeX is a long and somewhat involved process requiring moderate technical knowledge. This program can be very difficult to use for some tasks, but the style sheets provided do make it relatively easy to produce high-quality output in several common formats. PC TeX has done an outstanding job of typesetting ballistic program documentation and has also produced several manuscripts, including King, Fatkin, and Hudgens (in press).

EXACT is much more suitable of the two packages for technical typesetting by general users. When used with Microsoft Word and a LaserJet printer, EXACT hardly changes output speed when compared to a source file output. EXACT produces a substantial degradation of output speed on the ALPS printer; only the draft mode is acceptably fast. PC TeX is most appropriate for users involved in the publication of technical manuscripts who require the highest quality technical typography. PC TeX should probably only be used with a laser printer, because the level of output performance, although slower than with EXACT, is quite good in that mode. When PC TeX is used, the dot-matrix printer output is too slow for most uses; although, as is the case with EXACT, the product is acceptable for proofing and related uses. General users, who are willing to expend some effort mastering PC TeX will find that the results are worth the effort.

Table 1

Features of EXACT and PC TeX

	EXACT[a]	PC TeX[b]
Fonts	10	88
Sizes per font	2	1-7, mode = 3
Installation (in minutes)	15	60
Real-time edit mode	Yes	No
Page preview	Yes	Yes
Formatting	Shared with word processor	TeX commands
Disk space (megabytes)	1.1[c]	15[c]
Directories	3[c]	52[c]
Approximate cost as installed	$700[f]	$900[g]

[a] Source: Technical Support Software, Inc.
72 Kent Street
Brookline, MA 02146
617-734-4130

[b] Source: Personal TeX, Inc.
12 Madrona Avenue
Mill Valley, CA 94921
415-388-8853

[c] Does not include a word processor or text editor.

[d]

EXACT	$480 (Recommended)
LaserJet Driver	$100 (Recommended)
EXACT to TEX Translator	$100 (Not recommended)

[e]

TeX, Preview, LaserJet Driver, books	$560 (Recommended)
PC Dot Driver	$100 (Recommended)
MetaFont	$200 (Not recommended)

[f] Combination of c and d

[g] Combination of c and e

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APPENDIX A

DIRECTORY STRUCTURE FOR EXACT

DIRECTORY STRUCTURE FOR EXACT

C:\ (root)	
C:\WORD	Microsoft Word files)
C:\COURIER	(EXACT files for dot-matrix printers)
C:\ELITE	(EXACT files for H-P "J" Math Elite cartridge)
C:\TMS	(EXACT files for H-P "K" Math TMS cartridge)

APPENDIX B

DIRECTORY STRUCTURE FOR PC TeX

DIRECTORY STRUCTURE FOR PC TeX

E:\ (root)

E:\PCTEX	(TEX program & BAT files, .TEX files)
E:\PCTEX\TEXFMTS	(TEX initialized format files)
E:\PCTEX\TEXBIB	(BiBTeX .BIB data files)
E:\PCTEX\TEXDOC	(Documentation files)
E:\PCTEX\TEXINPUT	(Style sheet, .STY, and related files)
E:\PCTEX\TEXTFMS	(Specialized text formatting files)
E:\PCTEX\PIXEL	(No files)
E:\PCTEX\PIXEL\DPI240	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI263	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI288	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI346	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI415	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI498	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI597	(Standard dot-matrix printer fonts)
E:\PCTEX\PIXEL\DPI300	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI329	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI360	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI432	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI518	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI622	(Standard laser printer fonts)
E:\PCTEX\PIXEL\DPI746	(Standard laser printer fonts)
E:\ARBORTXT	(No files)
E:\ARBORTXT\PREVIEW	(TeX Preview program files)
E:\ARBORTXT\FONTS	(Preview format files)
E:\ARBORTXT\PXLPROGS	(Pixel file-handling utilities)
E:\ARBORTXT\DEMO	(Preview demonstration files)
E:\ARBORTXT\DOC	(User .DVI files)
E:\TEXPIXEL	(No files)
E:\TEXPIXEL\PSPIXEL	(No files)
E:\TEXPIXEL\PSPIXEL\SCREEN	(No files)
E:\TEXPIXEL\PSPIXEL\SCREEN\DPI75	(Preview screen fonts)

E:\TEXPIXEL\PSPIXEL\SCREEN\DPI90 (Preview screen fonts)
E:\TEXPIXEL\PSPIXEL\SCREEN\DPI105 (Preview screen fonts)
E:\TEXPIXEL\PSPIXEL\SCREEN\DPI135 (Preview screen fonts)
E:\TEXPIXEL\PSPIXEL\SCREEN\DPI180 (Preview screen fonts)

E:\TEXPIXEL\CMPIXEL (No files)

E:\TEXPIXEL\CMPIXEL\SCREEN (No files)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI118 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI129 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI142 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI170 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI204 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI245 (Computer Modern screen fonts)
E:\TEXPIXEL\CMPIXEL\SCREEN\DPI294 (Computer Modern screen fonts)

E:\TEXPIXEL\CMPIXEL\CANON300 (No files)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI300 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI329 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI360 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI432 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI518 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI622 (NonHP Computer Modern fonts)
E:\TEXPIXEL\CMPIXEL\CANON300\DPI746 (NonHP Computer Modern fonts)

APPENDIX C

PC TeX MENU AND ITS CONFIGURATION

PC TeX MENU AND ITS CONFIGURATION

PC TeX Menu

This menu is invoked by typing PCTEX FILENAME, where FILENAME is M1A in this example, at the command line in the \PCTEX directory. The functions invoked are controlled by the modifications you make to the PCTEX.CFG file. Edit (E in PCTEX.CFG) invokes your text editor, Compose (C) sends the FILENAME.TEX to the TEX program, View (V) allows you to preview your file after it has been composed, Print (P) directs the output to a dot-matrix printer, and Typeset (T) sends output to a laser printer. Selections are made by moving a highlight to the desired selection using the cursor keys and then hitting ENTER.

```
        PC TeX  1987 (c) Personal TeX, Inc.

    Edit:      m1a.tex
    Compose:   m1a
    View:      m1a
    Print:     m1a
    Typeset:   m1a
```

PCTEX.CFG File

This file controls the effects of the functions selected from the menu shown above. It is located in the \PCTEX\TEXFMTS directory. This file must be customized to fit your particular installation. In this case, EDIT invokes a customized Wordstar located in the \PCTEX directory; DVIEPS is a .BAT file that calls PCDOT with appropriate parameters to output to an Epson-compatible printer, and HP is a batch file that calls TEX, PTIHP, and PTISPOOL in order, to output on a LaserJet. You must develop your own .BAT files to support these functions.

```
%E=EDIT %s          (Invokes a non-document version of Wordstar)
%C=TEX  %s          (Passes the specified .TEX file through TEX)
%V=\ARBORTXT\PREVIEW\PREVIEW %s     (Previews the .DVI file)
%P=DVIEPS %s        (Prints on an Epson-compatible dot printer)
%T=HP %s            (Prints on an HP LaserJet printer)
```